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SEM and HRTEM analysis of ZnS nanoflakes produced by a simple route

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Abstract In this work, we report the synthesis of ZnS nanostructures by a simple and eco-friendly method that makes possible producing nanoflakes at room temperature. Scanning electron microscopy and transmission electron microscopy methods (mainly bright-field, high resolution and high angle annular dark-field) were used to identify and study the obtained nanostructures. The structure of these nanoflakes consists of nanosized crystalline particles around 1.5 to 3 nm. Domains with different contrast of nanometer-size diameters are formed in the self-assembled nanoflakes as a result of a noncompact arrangement of nanocrystallites during agglomeration and differences in the presence of the organic passivation agent. Agglomeration can be attributed to the amount of crystallites generated at the beginning of the reaction or to an anisotropic interaction between phosphate ions and the surfaces of ZnS clusters, and consequently a bottom-up synthesis is considered, which opens a simple route for the production of nanomaterials with the inclusion of extra elements by a simple way.

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1 Introduction

Novel materials, mainly at the nanoscale, are characterized by the induction of properties based on their size, composition and morphology. Particularly, nanostructures are commonly considered as the entry into a new realm in physical, chemical and biological science because of the impact that is expected to the application of these materials on those fields.

Zinc sulphide (ZnS) was one of the first semiconductors discovered, and is considered important due to multiple possible applications [1, 2]. ZnS is mostly found in one of two structural forms—cubic sphalerite or hexagonal wurtzite—which at 300 K have wide bandgaps of 3.72 and 3.77 eV, respectively [3].

ZnS nanostructures have been reported in the literature. ZnS can form quantum dots [4–8], nanowires [9, 11], nanoribbons [12], nanobelts [13], nanocable-aligned tetrapods [14], nanohelices [15], nanodisks [16], nanosaws [17], nanotowers [18] and even the so-called nanoflowers [19]. Synthesis of these nanostructures has been made by thermal evaporation techniques [9–15, 17, 20] and from structured hybrid matrices through a gas–solid reaction [16].

Although ZnS nanostructures have been extensively studied, only a few studies of compositional differences inside ZnS nanostructures have been published [20–22]. To have more experimental data of an alternative character that might help to provide insight on the growth mechanism and